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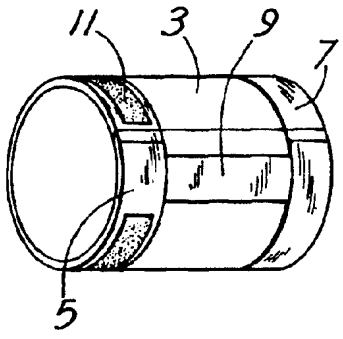

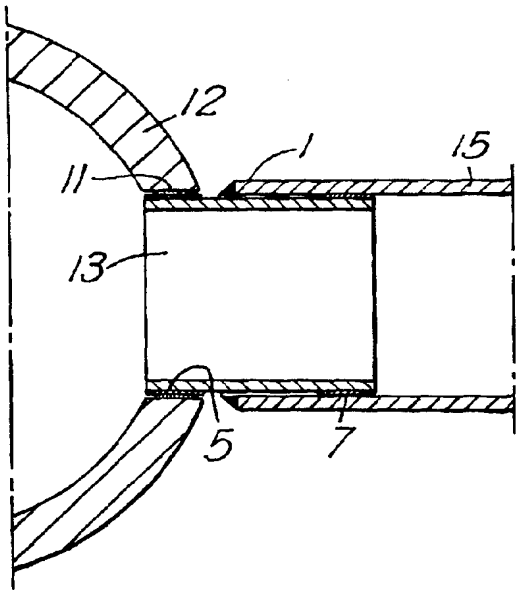

(57) Abstract

A method of covering a pipeline, which can be carried out either in the factory or in the field comprises enveloping the pipeline with a covering such as a helically wound tape (20) comprising a heat recoverable layer (21), having first surrounded the pipeline with a thermal barrier layer (such as a mastic (23)) that bonds to the pipeline without the application of heat. A heat activatable adhesive (22) is used to bond the heat recoverable layer (21) to the thermal barrier layer. In the most preferred embodiment the thermal barrier layer and adhesive layer are pre-applied to the heat recoverable tape, and one edge (24) of the tape is bare of thermal barrier layer to allow good bonding between adjacent overlapping turns of the tape.

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Article and Method for Modifying the Surface of a Substrate

This invention relates to articles that, at least in part, comprise conductive polymeric materials and are electrically heatable and methods for lining, repairing, joining, reinforcing or otherwise modifying elongate substrates such as pipes or cables using such articles, particularly the internal surface of hollow elongate substrates, especially pipelines. The invention finds particular application for lining, joining, re-joining, or repairing the joint between a lateral and a main pipeline.

It is know to line pipelines or line joints of lateral connections to main pipelines using polymeric lining sleeves inflated within the pipeline. EP-A-0377486 A, for example, describes a method of lining a straight pipe using a circular cross-sectioned liner tube that has been deformed to a non circular shape to insert it into a pipe, and then reverted to its circular shape by filling with a hot liquid. US-A-4434115 describes lining of a lateral connection to a pipe by inverting a lining tube, by means of fluid pressure. The lining is preferably flexible but hardenable to form a rigid tube inside the connection.

It is also known to use electrically heatable articles comprising conductive polymeric materials to modify the surface of a substrate. EP-0343757 B1, for example, describes a method of joining together the outer surfaces of articles made from heat softenable compositions, e.g. polymeric pipes, using a non-heat-recoverable conductive polymeric element (preferably carbon-black-containing UHMWPE) positioned in contact with the article or next to an insert, which element is heated to join it to the article either directly or via the insert.

Similarly, WO-88-06517 describes a sintered UHMPWE element which undergoes a dimensional change when heat is generated within it, and which can be used to join first and second articles that it is positioned between.

We have discovered a new article and method that are particularly useful for modifying the internal surface of a pipeline, and are particularly applicable for joining a lateral pipeline to a main pipeline.

A first aspect of the invention provides a method of modifying the internal surface of a hollow elongate substrate using a wraparound article comprising a polymeric, preferably flexible, backing sheet (ii) an electrically heatable element comprising a conductive polymeric material, bonded to the backing sheet and

covering at least part of the backing sheet, and (iii) optionally a sealing means covering part or all of the electrically heatable element, the method comprising:

(a) wrapping the article to form a tube with overlapping longitudinal edges with the heating element positioned outwardly of the backing sheet, and inserting the wrapped article within the substrate,

(b) connecting the heatable element to an electrical power source to cause electrical current to flow through the element, to heat and to bond at least part of the outer surface the element to the inner surface of the hollow elongate substrate, either directly, or by means of, or enhanced by, the optional sealing means.

Preferably the electrically heatable element covers part only of the surface of the flexible polymeric backing sheet.

In one construction the wraparound article and backing sheet are substantially rectilinear, and the backing is wrapped so longitudinal edges overlap and can bond together to form a tube. In this case, the electrically heatable element preferably comprises a strip extending along one of the longitudinal edges, which strip can be activated to form the overlap bond. In this case, also, preferably the heatable element comprises a strip extending annularly at one or preferably both ends of the wrapped sheet, on the outer surface as wrapped. These additional heating elements serve to bond each end of the sheet to the inner surface of the substrate.

The advantage achieved when only part of the backing sheet is covered by a heatable element is that the remainder of the sheet is not heated, and hence any potential problem of thermal shrinkage of the sheet, away from the inner surface of the substrate, after heating for installation is completed, is reduced compared to the situation when the whole backing sheet is covered by a heatable element.

The electrically heatable element may itself be of such a nature that it can bond itself to the substrate. If not, or in any case, a sealing material, e.g. an adhesive such as a heat activatable, especially a hot melt adhesive, or a mastic may be included to form or to enhance the bond. This sealing material may cover, part or all the outer (when wrapped) surface of the electrically heatable element. The nature of the sealing material will depend on the nature of the substrate which is being bonded to. For example, for sealing to the inside surface of a concrete main pipe it is useful to

include a strip of mastic material as a sealing material. The same or different types of sealing material may be used to cover different parts of the heatable element.

The electrically heatable element comprises a conductive polymeric material. Conductive polymers are well known. They comprise a polymeric component and, dispersed or otherwise distributed therein, a particulate conductive filler, e.g. carbon black. Conductive polymers have been widely used in electrical heaters, including heaters which are in the form of heat-recoverable articles or which are secured to heat-recoverable articles so that, by powering the heater, the article can be caused to recover.

The conductive polymer composition ued in the invention preferably comprises polyethylene, particularly ultra-high molecular weight polyethylene (UHMWPE) together with a particulate conductive filler, especially carbon black. In general the composition preferably consists essentially of

(a) a matrix consisting essentially of organic polymer particles which have been sintered together so that the particles have coalesced without completely losing their identity, and

(b) a particulate filler, preferably carbon black, which is dispersed in said matrix but which is present substantially only at or near the boundaries of the coalesced particles.

Further details of the preferred material can be found in PCT/US88/00592 the disclosure of which is incorporated herein by reference.

The present invention has many applications, and can be used, for example, to seal to the inner surface of polymeric (e.g. polyethylene, or polypropylene), metal (e.g. stainless steel), concrete or clay substrates. The result is a smooth profiled inner seal that does not significantly interfere with the inner volume of the substrate, e.g. flow through a pipeline.

The applications of the present invention including sealing and repairing inner surfaces of substrates, and also joining such substrates. Where a joint is required e.g. between pipes, the article must be sufficiently strong to act as a coupler. It is preferably at least as strong, and as tough as the substrates being jointed. Where the substrates being joined are pipelines that are to be buried in soil, they will be subject,

in use, to soil stresses (or in other applications where substrates are exposed to similar in-use stresses) the article should preferably also be flexible enough to accommodate such stresses. This is a matter for the man skilled in the art to balance the nature and thicknesses of the materials used. In general the article should be at least 3mm thick.

In order to install the article it must be inserted into the substrate, brought into contact with the inner surface of the substrate, and then electrically powered to heat it to bond it to the substrate inner wall. The installation and bringing into contact with the substrate wall can be carried out in any convenient way, e.g. by fluid inflation or mechanical means. Operation is preferably carried out remotely, especially in applications where the substrate is inaccessible, e.g. a buried pipeline. Similarly the electrically activated bonding is preferably carried out remotely.

Particular applications of the present invention that should be mentioned include making a new connection between a lateral pipeline and a main pipeline, relining of old pipelines e.g. sewer pipelines, and internal connections between two butted polymeric pipes.

For a lateral pipe connection a tunnelling device is first used to drill a hole through the first pipe (of diameter similar to that of the outer diameter of the lateral pipe). The lateral pipe is then brought close to the hole, and then the article of the invention is inserted within the lateral pipe so that one end thereof extends into the hole to a depth approximately equal to the thickness of the main pipeline. That end of the article can then be heat activated to bond it to the cut surface through the thickness of the wall of the main pipeline. Simultaneously, previously or subsequently bonds may also be achieved at the other end of the article (to the lateral pipeline) and between the overlapping longitudinal edges of the article itself.

The invention also provides a wraparound article for modifying the internal surface of a substrate, the article comprising:

(i) a flexible polymeric backing sheet,

(ii) an electrically heatable element, comprising conductive polymeric material, bonded to the backing sheet and covering at least part of the backing sheet,

(iii) sealing means covering part or all of the exposed surface of the electrically heatable element to form or to enhance a bond between the electrically heatable element and the internal surface of the substrate.

The article of the invention preferably incorporates the features described above.

An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings, wherein:

Figure 1 is a plan view and Figure 2 is a side view of an article according to the invention

Figure 3 shows the article of Figures 1 and 2 in a wrapped configuration ready for installation, and

Figure 4 is a sectional view which shows the article of Figures 1 to 3 installed within and between a main and a lateral pipeline thereby forming a connection between the two pipelines.

Referring to the drawings, the article, shown generally by the reference numeral 1 comprises a rectangular backing layer of polyethylene 3 having three strips 5, 7, and 9 of conductive carbon black loaded ultra high molecular weight polyethylene bonded along the two long and one short edge of the polyethylene backing layer 3. These act as the electrically heatable elements according to the invention. Each of the conductive strips 5, 7, and 9, also includes two elongate bus bars (not shown) extending along the edges of each strip which can be used to supply electrical power to the conductive polymeric material. This is done in the manner described in PCT/US88/06517. A coating layer of a mastic material 11 is also included on one of the long conductive strips, strip 5. This covers most but not the entire surface of strip 5. It does not extend to the edges of the strips, since the edges (on the outer side of the position of the bus bars) are not heated and are effectively dead areas. Referring to Figure 2 it can be seen that the short ends 3' of the backing layer 3 are tapered. The purpose of this is to reduce the profile of the wrapped sheet.

In order to install the article of Figure 1, it is first wrapped, with the backing layer 3 innermost, so that the longitudinal edges 3' of the backing layer 3 and also the adjacent area of the backing sheet overlap, so that the heatable strip 9 underlies an

overlapped region of the backing layer 3. The wrapped configuration is shown in Figure 3.

Figure 4 shows a main concrete pipe 12 which has a hole 13 tunnelled therethrough, and a lateral polyethylene pipe 15 arranged substantially perpendicularly to the main pipeline 12 and brought into close proximity to the main pipe 12. The wrapped article of Figure 3 has been inserted within the lateral pipe so that the end thereof which is coated with mastic lies within the concrete pipe 12. Electrical power is then supplied remotely, and simultaneously to each of the conductive polymeric strips 5, 7, and 9, via their bus bars. This causes the following bonds to be formed. A bond is formed directly between the conductive polymeric strip 9 and the overlapped longitudinal edge of the wrapped backing layer 3. A bond is formed directly between the outer surface of the conductive polymeric strip 7 and the inner surface of the lateral pipe 15. Also, the conductive polymeric strip 5 heats and activates the mastic 11 which bonds to the cut surface of the wall of the main pipe 12. The bonds may be formed simultaneously, or sequentially, in any order. In a preferred embodiment each of strips 7 and 9 is covered with a thin skin coating of high density polyethylene which enhances the bond between the conductive polymeric strip and the lateral pipeline (in the case of strip 7) and the overlapping backing layer 3 (in the case of strip 9)

The bond formed according to this specific example between the lateral pipeline 15 and the main pipeline 12 is sufficiently strong to withstand use, but also sufficiently flexible to withstand soil stresses if the pipelines are buried in soil.

EXAMPLE

The following example describes one particular article which could be used in the present invention.

Polyethylene Backing layer (Ref 3 in Fig 1): Rectangular size 30 cm by 75 cm. Thickness over bulk of layer 3mm. Thickness tapering to zero at ends (3' in Fig 2) over a distance of 40 mm.

Ultrahigh molecular weight polyethylene (carbon black filled) strips Thickness 0.8 mm. Two long strips (ref nos. 5 and 7 in Figures) 73cm by 6cm. Short strip (ref 9 in Fig 1) 16cm by 6cm.

Mastic coating (on strip 5 in Fig 1) Thickness 1mm. Extending across 5cm of width of conductive strip 5.

Conductive polymeric strips (5 and 7 in Fig 1) cover 3cm of the 4 cm of taper of the polyethylene backing layer at its ends.

CLAIMS

1. A method of modifying the internal surface of a hollow elongate substrate using a wraparound article comprising a polymeric backing sheet (ii) an electrically heatable element comprising a conductive polymeric material, bonded to the backing sheet and covering at least part of the backing sheet, and (iii) optionally a sealing means covering part or all of the electrically heatable element, the method comprising:

   (a) wrapping the article to form a tube with overlapping longitudinal edges with the heating element positioned outwardly of the backing sheet, and inserting the wrapped article within the substrate,

   (b) connecting the heatable element to an electrical power source to cause electrical current to flow through the element, to heat and to bond at least part of the outer surface the element to the inner surface of the hollow elongate substrate, either directly, or by means of, or enhanced by, the optional sealing means.

2. A method according to claim 1, wherein the electrical heatable element covers part only of a surface of the backing sheet.

3. A method according to claim 2, wherein the backing sheet is substantially rectilinear, and the electrically heatable element is in the form of strips extending along three sides of the sheet.

4. A method according to claim 1, 2 or 3, wherein the electrically heatable element comprises ultrahigh molecular weight polyethylene containing a conductive filler, preferably carbon.

5. A method according to any preceding claim, wherein the sealing material comprises a mastic or a hot melt adhesive.

6. A wraparound article for modifying the internal surface of a substrate, the article comprising:

   (i) a flexible polymeric backing sheet,

(ii) an electrically heatable element, comprising conductive polymeric material, bonded to the backing sheet and covering at least part of the backing sheet,

(iii) sealing means covering part or all of the exposed surface of the electrically heatable element to form or to enhance a bond between the electrically heatable element and the internal surface of the substrate.

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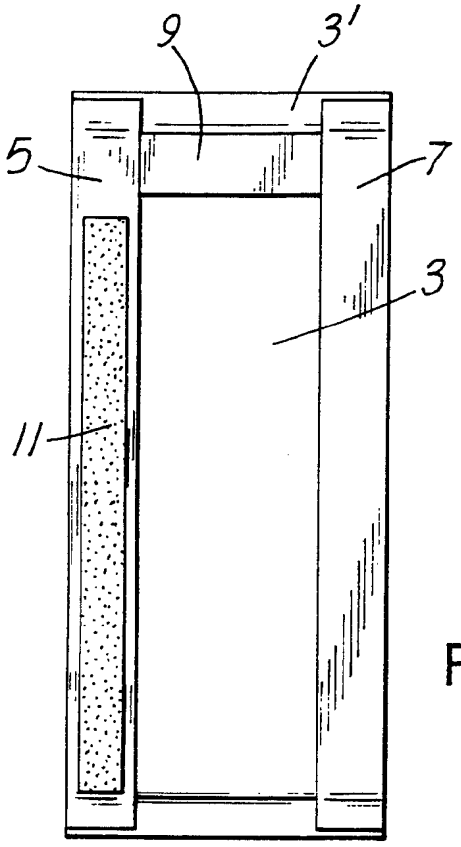

Fig.1

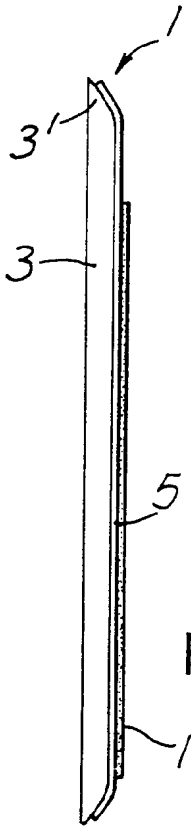

Fig.2.

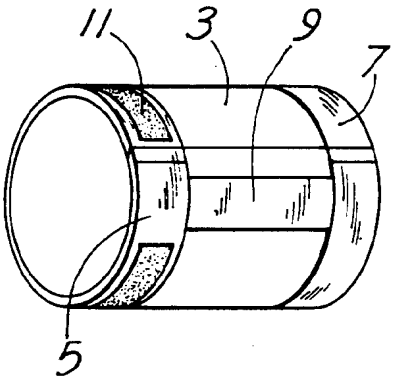

Fig.3

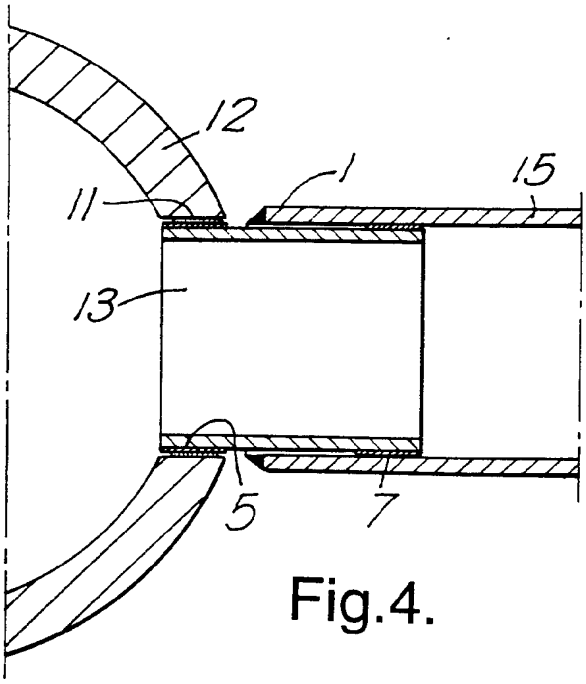

Fig.4.

INTERNATIONAL SEARCH REPORT

Inten. nal Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 F16L47/02 B29C65/34 F16L55/165

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 F16L B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP,A,0 236 056 (N. V. RAYCHEM S.A.) 9 September 1987 see abstract; claim 1 ---	1-6
A	EP,A,0 498 602 (NIPPON ZEON CO., LTD.) 12 August 1992 see claim 1 -----	1-6

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
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